Soil Moisture Modeling and Observations: A National Weather Service Hydrology Perspective

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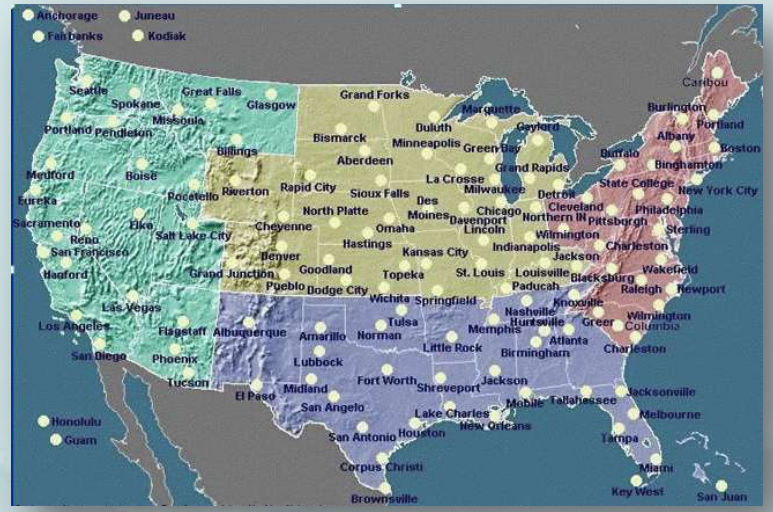
Introduction

- Hydrologic forecasting depends on spatially dense, three dimensional, accurate assessments of soil wetness and freeze/thaw state
- Impact of improvements
  - Better flood monitoring and forecasting
  - Better management of water resources

13 River Forecast Centers

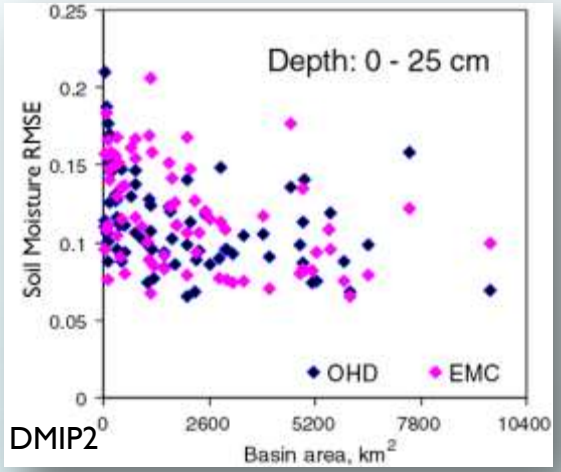


122 Weather Forecast Offices

How is soil moisture used in hydrology?

Soil Moisture for Hydrology: Validation and Direct Use

- Research model validation and assimilation
- Operational model validation and forcing

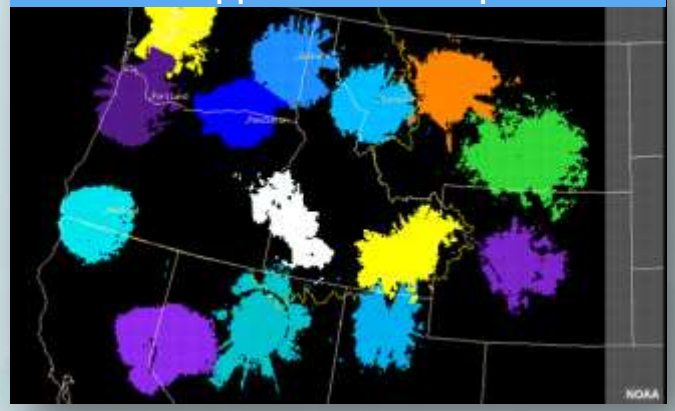


- Research
  - Verification of NLDAS and DMIP2 model output
  - Verification of CREST-OHD SAC-HTET SMOS assimilation simulations
  - Use of soil moisture observations for forecasting crop production
- Operations
  - Future validation of NOHRSC CONUS SAC-HTET, Noah, and CLM simulations
  - RFC Fertilizer runoff forecasts
  - Potential use of soil moisture observations for flash flood guidance

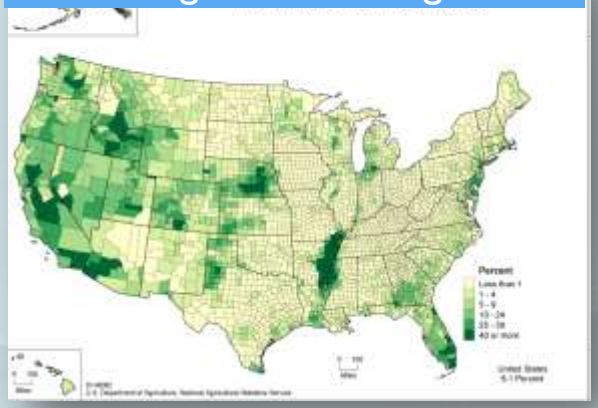
Soil Moisture for Hydrology: Calibration & Assimilation

- Soil moisture observations used alongside discharge for calibration
- Assimilation efforts underway that will potentially:
  - Improve initial model conditions and forecast stream flow
    - Assist with issue of Doppler radar and rain gauge gaps
    - Account for the increase in moisture from irrigation
    - Correct model biases
  - Increase accuracy of soil moisture states for drought monitoring (leverage ongoing EMC-OHD NOAA MAPP-funded drought task force project)

Doppler Radar Gaps



Irrigation Coverage



Soil Moisture Network Needs

→Lessons Learned

Soil Moisture Network Needs

- Concern: What does “soil moisture” mean?
  - “Surface” and “Deep” have different meanings to users
  - Farmers think of the root zone, SMAP users as top few cm
  - It is not possible to arrive at a single definition for all uses

- Many different communities…expert, novice, research, operational
- Many different meanings
- Therefore must have sufficient metadata to fully qualify any measurements

Soil Moisture Network Needs

- Concern: It is not always clear how soil observations are obtained
  - What probes are used? (measure different variables)
  - Are there handicapping measurement limitations?
  - Lack of standardization

- Improve standardization
- Provide true measurement of soil properties at probes
  - Will allow for intercomparison and informed blending of measurements and models

Soil Moisture Network Needs

- Concern: There are too many separate sources of measurements
  - Hard for user to determine the “best” network to draw on

- Leverage where possible, rather than duplicate
- Recognize the many potential users and needs
- National Weather Service
  - High availability
  - Quality control
  - Metadata, including true soil parameters
  - Standardization of measurements
  - Ease of ingest into operational systems
  - Low latency, high repeat time, high density

Soil Moisture Network Needs

- Concern: What design characteristics should the network have?
  - Soil moisture can be highly variable in space, depth, and time
  - Varying use…climate community may value daily/monthly data, while flash flood forecasters may need much finer resolutions

- Spatially and vertically dense network may be needed
  - Design could be guided by soil type, land use, climate
  - Guidance obtained from data inclusion/denial studies
  - Intended use offers guidance as well
    - Flash flood applications—high station density, low latency
    - Cold-season flood areas—detailed freeze/thaw info
    - Drought monitoring—less density, longer repeat time
    - May need to aim to support most demanding application

Concluding Thoughts

- Broad range of end users and end uses should be a primary driving factor in design process
- Leveraging versus duplicating is important consideration
- True site metadata is vital for use of observations
- OHD will continue research into soil moisture modeling, observation, and assimilation
- Would like to be involved in further discussions on establishment of coordinated national soil moisture network
- We can contribute lessons learned and objective results in the hydrologic domain